

MAHARANA MEWAR PUBLIC SCHOOL



Session: 2025-2026

When the Ingredients of Life turn against you

Class:- XII - D

Subject:- Biology (044)

Board Roll No. :-

Submitted By:- Taha Husain

Submitted to:- Dr. Madhubala Purohit (PGT - Bio)

Certificate

This is to certify that **Taha Husain** of **Class XII-D of Maharana Mewar Public School** has completed his project (**When the Ingredients of Life turn Against you**) under my supervision. I certify that this project is up to my expectations and as per the guidelines issued by the **Central Board of Secondary Education.**

Signature

Examiner

Signature

Dr. Madhubala Purohit (PGT - Bio)

Acknowledgement

I take this opportunity to express my profound gratitude and deep regard for my guide Dr.

Madhubala Purohit's encouragement throughout the course of this project, for her amazing guidance, and wisdom.

I also want to thank my peers who helped in developing the project, and people who have willingly helped me out with their respective abilities.

Introduction

So, On one fine day on my Diwali Break, I was studying Biology and was intrigued by how effectively HIV infects our body and dodges all of our Immune Responses.

So, I went onto a Discord server aimed at Biology and asked for someone to better explain to me how HIV works, and soon enough, I started chatting with a person who explained to me all about HIV with great detail and enthusiasm.

After the Explanation, they told me that I should search more about something called Prions (Short form for Protein Infections).

After that, I approached my Biology Teacher (Dr. Madhubala), and she told me what Prions were and how they work. I was immediately intrigued and researched more about Prions on the Internet (Wikipedia, Discord, Reddit, YouTube and any other possible source).

And That's How i made this Project. :D

Aim

The Aim of this Project is to study Prions and explore how protein misfolding challenges conventional ideas of life, immunity, and diseases.

Plus, This is also something where I will Document and Report all of what i found and Understood about Protein Infections (Prions).

(And to also Show Others how creations of life are always a 2-sided coin).

So, Without any further ado,

Welcome to the terrifyingly Beautiful world of Prions!

What happens when Proteins don't behave the way they were supposed to?

By now, It is widely known that Proteins are the main building blocks of all life around us, From the smallest of microorganisms to the largest mammals.

But Proteins aren't just 1-dimensional jumble of molecules.

They are a complex 3-Dimensional jumble of organic molecules whose shape is governed by how their molecules interact with each other through the Electromagnetic Forces (A Cameo from Physics and Chemistry right here!)

But sometimes,

Through pure Probabilistic chaos (Hello there, Math!), The Molecules interact a bit differently than normal and sort of "misfold" into shapes that are, well, not.... normal.

And voila, Through just a little bit of "Misfolding" (and a bit of bad luck), you have created a **Prion**.

A "Misfolded" protein that is ready to cause havoc in both Humans and Animals alike.

Also, A Prion is not a living thing like a Bacteria or Fungi, It is quite literally just a jumble of not so random molecules folded the wrong way (As described above)

Discovery of Prions (No i did not discover them :/)

Directly quoting from the Internet here:

"In the early 1980s, American neurologist 'Stanley B. Prusiner' identified the "proteinaceous infectious particle", later shortened to prion.

The prion hypothesis posits that prions are infectious agents composed solely of protein. This was a radical departure from the central dogma of molecular biology, which states that genetic information is stored in DNA and RNA and then used to create proteins.

Prusiner's work challenged this dogma by suggesting that a protein itself could be infectious and replicate without nucleic acids."

Structure of Prion Proteins

Not all Prion Proteins actually cause infections (Although the name implies otherwise, but hey, I don't decide the names yk).

Some "Good" prions also exist throughout our bodies (especially in the brain), like 'PrP^C'. These proteins have a specific, well-defined structure that is mainly composed of flexible coils called 'alpha helices'.

However, Sprinkle in some Bad luck, and these normal Proteins misfold into their 'PrP^{Sc}' form in which some of the 'Alpha Helices' are stretched into flat structures called 'Beta Strands'.

This "evolution" from PrP^C → PrP^{Sc} causes these misfolded proteins to become resistant to cellular enzymes that would typically break these proteins down.

Thus, they begin to accumulate in your cells, which eventually leads to cellular damage.

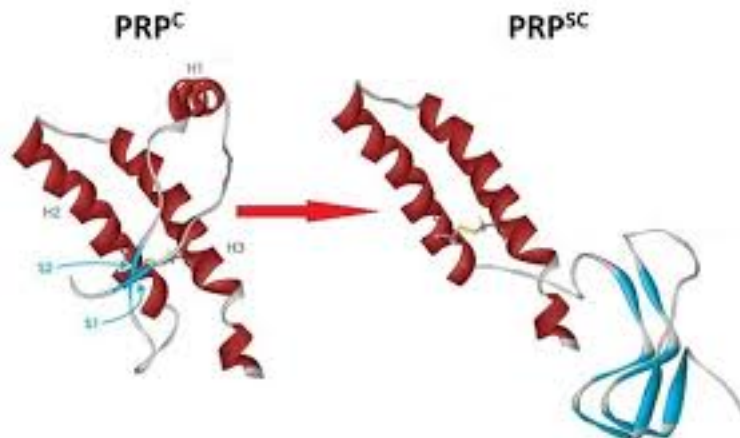
Now you might ask, If such harmful proteins exist in our bodies, then why didn't Natural Selection (Looking at you, Sir Darwin) weed out individuals with these proteins?

Well, the PrP^C protein's function in our body is not well understood at this point in time (Maybe I can be the first to do that :D).

But some theories suggest that PrP^C proteins may play roles in Cell Adhesion, Regulation of Cell Death, Long-Term Memory, Stem Cell Renewal, and Innate Immunity, among other things.

Some studies conducted on Mice (Sorry, mice) have shown that PrP proteins activate myelin repair in Schwann cells, and a lack of PrP proteins can cause demyelination in these cells.

Below is an Image Comparing a Normal PrP^C with a PrP^{Sc} Protein (Source - ResearchGate.net):



Alright, So How do these suckers replicate themselves?

Now, At First, this might seem really counterintuitive, as I mentioned above, that Prions are not really alive in the traditional sense, So how in the heck can they replicate themselves?

Well, I am telling you that they can, Let me explain

Prions replicate without any apparent DNA or RNA present, and they are just proteins, and this directly attacks the central dogma of biology, which states that information for replication can only flow from DNA → RNA → mRNA → Proteins → Enzymes. But comeon, Life would lose all of it's beauty if there were no exceptions to our set boundaries.

There are 2 Widely accepted models on how this replication occurs:

1- Fibril Model:

In this model, The PrPSc proteins exist as something called 'fibrils', and these fibril ends bind to the PrPc Proteins, converting them into the PrPSc form.

In this model, Something called 'Fibril breakage' also exists, which explains the exponential growth of the Bad PrPSc guys

2- Heterodimer Model:

This model for Prion replication involves the misfolded PrPSc protein acting as a sort of "template" to convert the normal PrPC protein into the "bad" form. This conversion is thought to occur when PrPSc binds to PrPC, causing it to "refold" into the PrPSc conformation.

And now this new PrPSc protein can go ahead and convert more of it's brothers into their evil counterparts, Which leads to exponential growth of these thingys.

Some Diseases caused by Prions and some of it's Symptoms

I apologise, but i didn't do much research on the diseases, but here they are anyway:

- Creutzfeldt-Jakob Disease (CJD)
- Gerstmann-Sträussler-Scheinker-Syndrom (GSS)
- Fatal Familial Insomnia (FFI)
- Variably Protease-Sensitive Prionopathy (VPSPr)
- Scrapie
- Bovine Spongiform Encephalopathy (BSE)
- Chronic Wasting Disease (CWD)

Something weird is seen in these diseases is that the Brain region which is affected by these diseases turns into a sponge-like texture due to the vacuoles that form in the affected Neurons.

Just like the image shown below:

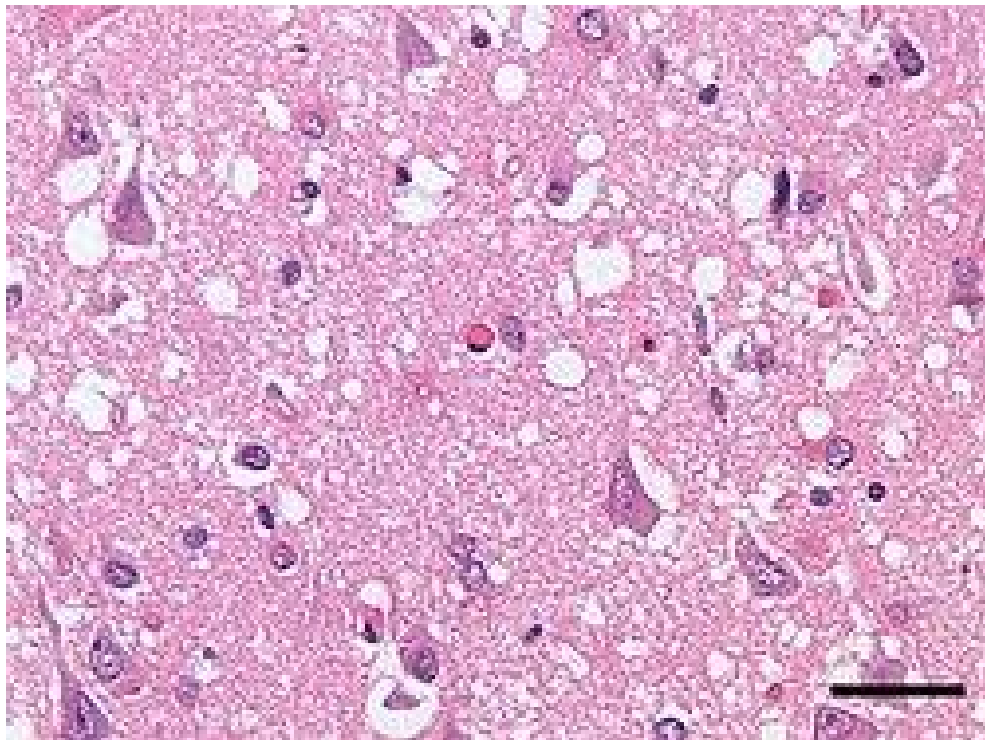


Image Source: Wikipedia

You Can Clearly spot the Vacoules forming in the Neurons in the above image,
Scary I know...

The symptoms of prion diseases vary but typically include:

- Rapidly developing dementia
- Difficulty speaking
- Hallucinations
- Confusion
- Muscle stiffness
- Ataxia (lack of coordination)
- Behavioural or personality changes

How Prions are Transmitted

- Ingestion
- Genetic Inheritance
- Prions can be transmitted through contaminated medical equipment too
- Spontaneous Misfolding
- Prions can persist in the environment, binding to soil and plants

Treatments and Prevention for Prions

Unfortunately for the time being, There exists no permanent cure for Prions.

The Treatment options are limited to managing symptoms and providing supportive care.

Prion diseases are almost always fatal...

The Preventive measures focus on reducing the risk of transmission:

- In Healthcare, Proper sterilisation of surgical instruments and avoiding the use of tissue from individuals with prion diseases.
- In food safety, Implementing strict regulations on meat production and processing

Ongoing Research about Prions

There is ongoing research regarding Protein Infections, How to better diagnose them and to discover ways to slow down the exponential growth and better manage their symptoms

Credits & Bibliography

Information sourced from: Wikipedia (The Wikimedia Foundation), YouTube, Discord, NCBI article on prion diseases, Reddit, Various Articles on the Internet found by Google.

Information compiled by: Your's Truly, Taha Husain!

Conclusion (At Last)

So, This Project was extremely intriguing for me to research and read about. I do hope that it was similarly as fun for you while reading all of the nonsense that i have rambled about here.

But researching about Prions definitely told me about how a lot of Research is still left to do in the world out there.

And I am so excited to one day contribute to it in any way, shape or form that I can.

I am reminded of a quote by Sir Stephen William Hawking here:

“Always try to look upto the Stars and not down at your Feet, There is still plenty more to find out”

Prions also teach us that Nature is always a 2-Sided coin. If it gives, it takes back too.

“There is no Good without the Bad, and no Bad without the Good”

-Trading Vessel Sunbeam (From the game Subnautica)

ThankYou So much for your time! :D

This is Taha, Signing off :3